CENTRAL OFFICE REPLACEMENT ECONOMIC STUDIES GUIDELINES

CONTENTS

1. GENERAL

1.1 Introduction

1.11 A new generation of switching equipment has been developed that promises to have widespread application to the REA borrowers that are considering replacing their existing electro-mechanical switching systems which are predominantly obsolete and depreciated step-by-step (S x S) switches. This new class of switch is referred to as a digital switch. The switch processing is performed by means of signals that are in a digital pulse code modulation (PCM) format.

1.12 In the past the REA borrowers generally studied one of the two following conditions in central office economic studies.

A. Location. With the establishment of a new franchised area or the growth of an existing area, a fundamental economic tradeoff study was made to determine the economic location of the wire center. This study would compare the cost of switching equipment versus outside plant cable or carrier systems.

B. Additions. Once a wire center is established it is unusually uneconomic to change its location, so economic studies generally consisted of selecting the most cost effective plan for additional switching equipment. In order to be compatible these studies usually required the addition of the same type of switching equipment. The economic study then simply selected the lowest first cost bid for the equipment.

1.13 With the introduction of digital switches, the REA borrowers now have a third alternative to consider in central office economic studies.

A. Replacement. The gross cost per port of a digital switch is currently less than the cost per line of a step-by-step (S x S) switch.

This fact alone requires that alternative plans be considered for introducing digital switching into the REA borrowers systems.

1.2 Purpose

1.21 The purpose of this section is to present guidelines to be used when developing alternate plans for the introduction of digital switches. These guidelines will be oriented toward answering the questions a borrower would have when he is developing a present worth of annual charges (PWAC) economic study that is to be submitted to REA as support for replacing an existing switch with a new switch. Several example studies will be included showing different approaches and methodologies acceptable to the REA.

1.3 Replacement Motivation

1.31 Two of the driving forces creating a favorable atmosphere for replacement of electro-mechanical switches with digital switches is older equipment and historical pricing trends.

1.32 The REA borrowers are in a position where a substantial proportion of their switching equipment is approaching the end of its service life. Approximately 90 percent of the 5300 REA financed exchanges are of the electro-mechanical type. In 1977 the average exchange had 693 main stations. The present age of the initially installed equipment is as follows:

Age	Percent of Switches
0-10 years	15
10-20 years	55
20 years or older	30

1.321 Typically, then, a REA borrower's exchange is equipped with a small S x S switch rapidly approaching the age and condition when replacement of the original equipment is a possible alternate plan and may be economically justified.

1.33 The trend has been for the price of S x S, Crossbar, and Analog Electronic switching equipment to increase rapidly and of digital circuit equipment to hold steady. A recent study by a large telephone company, as shown in Figure 1, illustrates this.

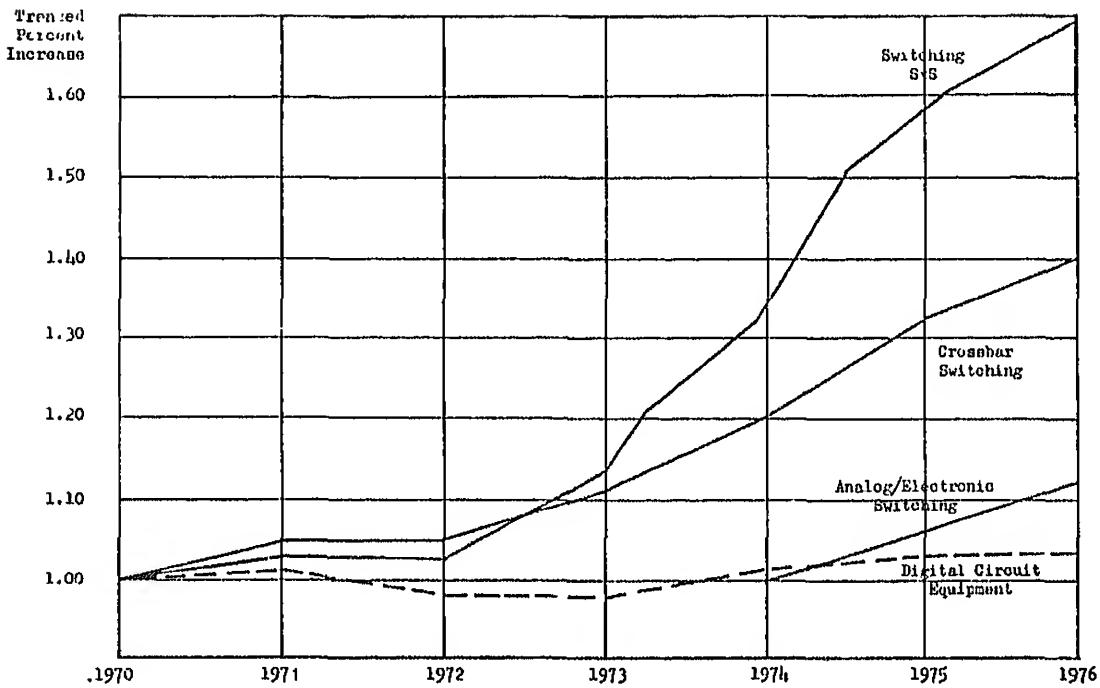


FIGURE 1 - Relative Percentage Price Increases
(1970 = 1.00)

1.331 It is anticipated that these trends will continue and the cost difference between S x S and digital equipment should become more favorable for digital equipment. With the reduction in manufacturing capacity for the new S x S market, the cost will go up and availability of new S x S equipment will be limited. Eventually, refurbished or remanufactured S x S equipment may be the only sources for additions to existing central offices. For the near future the amount of refurbished or remanufactured S x S equipment available to the open market will be in short supply and high priced because most of what is available from replacement of switches will be reused internally within each borrower's system.

1.332 Although there is no specific history of pricing trends for digital switching equipment available, there is reason to believe that its price will go up at a rate less than inflation. Volume production may even create a price reduction. Digital computers which are a similar product have this type of pricing history. In addition, the manufacturers of integrated circuits used in digital switches forecast a 50 percent reduction in costs within two to five years. This reduction in component costs should be reflected in reduced future costs of the digital switches.

1.4 Economic Studies

1.41 At this time there are no indisputable recommendations of when the replacement of an existing central office is economically justified. The REA review of over 150 proposals to replace a central office with a digital switch indicates that in most cases replacement is economically justified when the existing electro-mechanical equipment can be immediately reused within the borrower's system or can be sold for a high salvage value. On the other hand, replacement is rarely economically justified when only a small addition is required to a system that has only one electro-mechanical switch. There are many variables to consider that can affect the result so each case must be decided on its own merits which necessitates a "Central Office Replacement Economic Study".

1.411 The economic justification required for central office replacement is a cost comparison study. One of the most comprehensive measure of economics is a Present Worth of Annual Charges (PWAC) study which is the type to be used in REA studies. However, in some limited cases either an Annual Charge, Present Worth of First Cost, or First Cost study might be adequate. When any of these other types of studies are satisfactory will be discussed later in this TE & CM section.

1.42 This section will show what is necessary for a complete economic study. Acceptable guidelines and ranges of values to be expected will be developed for use by the borrower or his engineer.

1.43 REA TE & CM Section 219, "Present Worth of Annual Charge Studies for System Design", will be used as a basis for this section. The reader should be thoroughly familiar with the concepts in that section as this section will expand on it and treat in detail the items involved in economic studies.

2. ALTERNATE PLANS

2.1 Basic Requirements

2.11 In order to make an economic comparison, two or more long range alternate plans must be considered. One of the plans is a control plan and the others are the proposed plans. All reasonable alternate plans should be studied.

2.12 The control plan usually retains the existing equipment as presently installed and provides for necessary additions and rearrangements to furnish the required services. Where it is not possible to continue with present equipment, such as when production of a type of equipment is discontinued, then a control plan would consist of equipment replacement by the most apparent practical means.

.2 Study Time Frames

2.21 The most generally accepted time period criterion for a long range economic study plan is that it should be 2 to $2\frac{1}{2}$ times longer than the study planning period and that the study planning period should end with the last major addition in the study. See Figure 2.

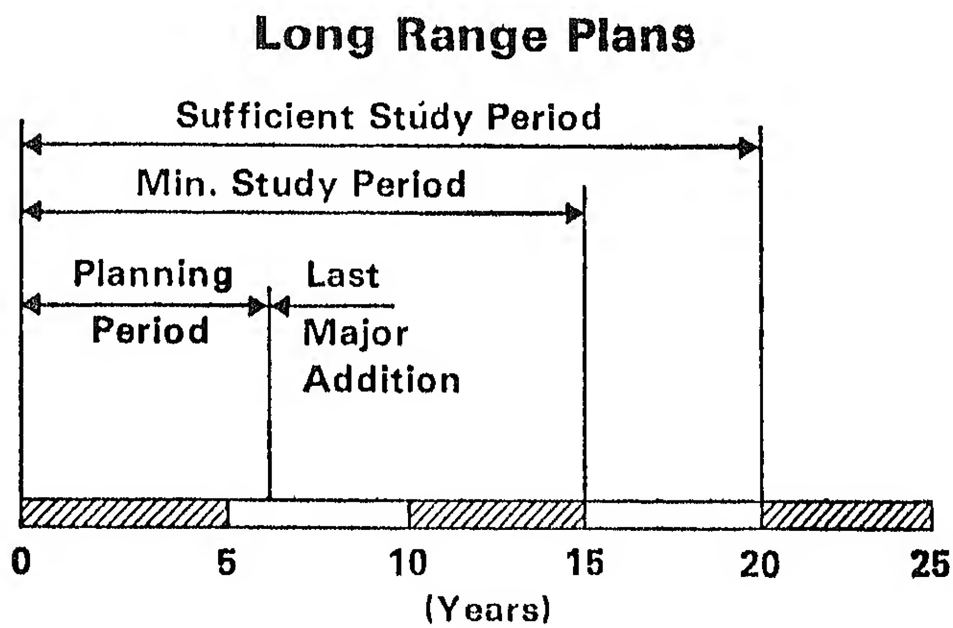


FIGURE 2

2.22 Central office switching additions are generally installed on a repetitive basis every three to six years to accommodate exchange growth. Therefore, in central office economic studies there is generally no last major addition on which to base the length of the planning period and subsequently the time period for the proposed economic study.

2.221 An acceptable guideline for the planning period of a central office economic study is that the study should include all additions required within a time period of between 6 to 8 years. Beyond this time period the accuracy of the projected unit costs and subscriber forecasts are

questionable and would therefore provide unreliable criteria on which to recommend a major change from the control plan.

2.23 The length of the central office economic study based on the planning period in paragraph 2.221 and a $2\frac{1}{2}$ multiplier criterion from paragraph 2.21 should then range between 15 to 20 years.

2.231 No study should be less than 15 years long in order to give sufficient economic weight to at least the first or second subsequent additions after the initial installation.

2.232 It is not necessary to extend a study length beyond 20 years because the differences in the economic factors are small and the resultant PWAC differences between competing plans are small. If the borrower chooses to use a study period longer than 20 years with the related economic factors, it is correct and acceptable to do so, but not required.

2.3 Alternate Plan Equivalency

2.31 All alternate plans considered in an economic study must be functionally equivalent throughout the study time period.

2.32 At the end of the study period all alternate plans must have approximately the same capacity for service. To accomplish this the same number (as practically possible) of lines, ports, trunks or other major items should be furnished. Similarly, all plans must provide approximately the same capacity for service at every major addition point in the planning period.

2.33 New or additional special services such as custom calling, push-button dialing, call forwarding, call waiting, or speed calling, etc. are to be included in the economic study only if the same feature(s) are included in all plans. A cost-revenue benefit study would be required as part of the marketing effort on a new service to determine if the service is potentially profitable. It would not be used in the central office replacement economic study unless a similar study was made for each alternate plan.

2.4 Implementation Schedule

2.41 The first step in developing economic plans is to determine the quantities of equipment needed to provide the services and then developing an implementation schedule.

2.42 The quantities of equipment required are based on the difference between the amount of equipment presently available and the projected amount required. The projected amount is determined by the borrower in his long range plan using past historical data, announced future events and his judgment of the local conditions.

2.43 Once the needs have been determined, different possible schedules for equipment additions are prepared. The equipment could be added in one step or in a succession of smaller steps. Other possible schedules would add equipment according to price advantages for quantities or according to the timing of equipment exhaust dates. These various alternate schedules become the alternate plans to be studied. Schedules for all practical alternatives should be developed keeping in mind that the time period must be equivalent for all alternate plans.

2.5 Additional Alternate Plans

2.51 In addition to alternate plans based on the timing of growth additions implied in the previous paragraphs, there are other items to consider that might create additional alternate plans.

2.52 The advancing age of the switches in the borrowers system will furnish a continuing need to study a complete replacement and this study could provide several alternate plans to consider.

2.53 Office consolidation with the use of remote concentrating equipment should be considered. The determination of which office should be the host switch and which office(s) should be remote(s) switches are alternate plans to be studied. Whenever remote digital switches are considered, one alternative that must be studied is the provision of separate digital switches at each location. With the problem on noncompatibility between host and remote switches of different manufacturers, this will show the cost or savings of being committed to one manufacturer.

2.531 Another possibility is the use of wideband coaxial cable as a remote pair-gain device. Subscriber carrier and line concentrators are other pair-gain devices to be considered in alternate plans involving remote equipment.

2.532 If the amount of switching equipment in an alternate plan is changed as a result of the use of remote switching or pair-gain devices, the differences in outside plant costs must be included in the economic study.

2.54 The economic effect on settlements with the connecting company such as the loss of line haul or the small exchange factor in the agreement must be considered and could provide other alternate plans to offset any adverse effects.

2.55 Additional alternate plans could be developed based on different building additions, primary power costs or maintenance costs that impact differently on the type of switching equipment proposed.

2.551 Whenever an equipment addition necessitates adding to the central office building, alternate plans should be developed that would postpone or forestall the addition. This could be accomplished by providing a

smaller addition or change to a switch such as a digital switch that takes less space. A digital switch of equivalent size takes one-third of the space of a S x S switch. A long range plan should not require additional space for central office switching beyond current needs.

2.552 If a plan to upgrade to all one-party service is contemplated, an alternate plan of replacing the present S x S switch with a digital switch should be considered because of the cost of a large S x S addition.

3. TYPES OF ECONOMIC JUSTIFICATION REQUIRED

3.1 PWAC (Present Worth of Annual Charges)

3.11 One of the most comprehensive indicators of economic justification is a PWAC study. It is also one of the most complex of the types of studies performed. In some cases a less complex study will provide sufficient justification, but the general recommendation is to furnish a PWAC study unless a definitive answer can be proven with a less complex study.

3.12 The object of a PWAC study is to determine the total equivalent amount of capital (dollars) that would be required at the present time (plan year 0) to complete each plan. The value of each plan is then reduced to a total single amount of dollars at the start of the proposed project (present worth). All plans can then be directly compared on this single value and the one with the lowest total present worth is the most economical over the entire plan period. What is required is the total present worth of each plan.

3.13 In plans where equipment only is proposed, the total PWAC of the plan is determined by first developing the annual charge associated with each line entry of equipment, converting the annual charge to the PWAC value and then summing all individual PWAC values.

3.14 For plans where cash settlements are made on a yearly basis, such as LAMA settlements, the total PWAC of the plan includes finding the present worth of these settlements. Methods of determining the PWAC value of these cash payments will be shown in the next section.

3.2 AC (Annual Charge Study)

3.21 The annual charge type of economic study has all the same components as a PWAC study except that it does not convert the items to their present worth.

3.22 An annual charge factor is developed for each major item of equipment that accounts for the operation and maintenance of the equipment over its service life. This factor is multiplied by the first cost of the equipment to provide an annual charge for each item. The sum of all annual charges is the total annual charge for that plan.

3.23 The annual charge study provides sufficient economic justification to choose between competing plans when either of the two following conditions are met:

A. All annual charges are constant over the entire study period.

B. The annual charges, if they vary, always favor one plan over the other plan(s).

3.24 In lieu of the present worth of annual charges of competing plans, the next best indicator of economic justification is the annual charge study.

3.3 PWFC (Present Worth of First Costs)

3.31 A PWFC study does not include all the factors necessary to determine the economic justification between competing plans. For example, a PWFC study does not include factors that account for operation and maintenance of the proposed system for the time period involved.

3.32 The sum of the individual first costs multiplied by the appropriate present worth of a single future amount factor is the total PWFC for that plan. This value represents the amount of capital (dollars) required today (plan year 0) that when invested at the cost of money will provide the necessary first cost capital at the needed points in time to purchase the desired equipment.

3.33 A PWFC study provides sufficient economic justification between competing plans only when either of the two following conditions are met:

A. The annual charge factors for all comparable line items in competing plans are identical.

B. The annual charge factors, if they vary, always favor one plan over the other plan(s).

3.4 FC (First Cost Study)

3.41 An FC study is the least desirable indicator of economic justification because it does not take into account operation and maintenance costs, the cost of money, or the timing of expenditures. These additional factors can easily change the financial advantage one plan has over another.

3.42 FC studies consist only of summing up the first costs of all the items in the plan. The amounts determined represent only the total amount of capital (dollars) required to be budgeted.

3.43 FC studies provide sufficient economic justification between competing plans only when Item A and either Item B or C of the following conditions are met:

A. All comparable line items are provided in all plans at the same time.

B. All comparable line items in all plans have identical annual charge factors.

C. Any differences in timing or annual charge factors always favor one plan over all other plan(s).

3.5 Simplifying Economic Studies

3.51 In economic selection studies only the differences between plans are important. The total magnitude of the project is a matter for the budgeting process. Therefore, a first criteria in simplifying economic studies is to eliminate all line items that are identical in size, unit costs, timing and annual charges.

3.52 With the identical line items removed the next step is to determine what level of study is required for economic justification. If a study fits the narrow requirements outlined above for a FC, PWFC, or AC study, then limiting the study to one of these will eliminate some mathematical work. However, the rule again is: When in doubt as to whether a full PWAC is needed, by all means do a PWAC study.

3.6 Judging Between Competing Plans

3.61 It often happens that when a study is completed one of the proposed plans is more economical than the others on a PWAC basis while another plan is more economical on a PWFC basis, etc. In such cases, the following preferential order of importance should be used for selection among the four economic study types:

A. PWAC (Accounts for Cost of Money, Operation and Maintenance, Timing)

B. AC (Accounts for Cost of Money, Operation and Maintenance, Limited Timing)

C. PWFC (Accounts for Cost of Money, Timing)

D. FC (Accounts for Capital Requirements Only)

4. ECONOMIC STUDY COMPONENTS

4.1 Major Line Items

4.11 After developing long range alternate plans and implementation schedules, the next step in preparing an economic study is to list all major items.

4.12 These items can be listed in any order that is useful and logical to the borrower. Chronological order is a common and useful method.

In multi-exchange plans, groupings of items by exchange are desirable. The arrangement of items preferred by the borrower is satisfactory as long as all major items are listed on an individual line basis.

4.13 Of the major items listed below, some might appear in any particular plan. This list is not meant to be all-inclusive since other items could appear in any particular plan.

A. Initial Lines
B. Line Additions
C. Trunks
D. Common COE Equipment
E. Connectors
F. Selectors
G. Central Office Batteries
H. Remote Switches
I. Concentrators
J. Ports
K. ANI
L. TSPS
M. LAMA
N. Cost of Installation
O. Retained Plant
P. Reconditioned Plant
Q. Cost of Reconditioning
R. Cost of Removal
S. Salvage
T. Associated Outside Plant
U. "T" Carrier
V. Remote Line Costs
W. Primary Power Equipment
X. Primary Power Cost
Y. Building Costs
Z. Land Costs
a. Maintenance Savings
b. Traffic Measuring Equipment
c. Push Button Dialing
d. Custom Calling
e. Line Haul
f. Toll Settlements

4.2 <u>Reducing the Line Items</u>

4.21 From the above list of items, the amount of engineering time required for a PWAC study could become appreciable.

4.22 Since economic selection studies are studies of <u>differences</u> between plans it is acceptable to eliminate all items that are identical to all plans over the full time period of the study. These items are necessary in developing the long range alternate plans, implementation schedules, and construction budgets, but can be eliminated in the economic studies.

4.3 <u>Unit Costs</u>

4.31 The unit costs associated with each item generally require the most engineering judgment of any part of an economic study. Except for firm quotes on current unit costs, all other unit costs involve forecasting the expected future price.

4.32 Whatever unit costs are used, they must be acceptable to both the borrower and the reviewers. Agreement must be reached among the borrower, his engineer, the REA field representatives and the REA Area Office representatives.

4.33 Unit costs for new equipment or additions can be obtained from similar recent projects.

4.34 Unit costs can have an inflation factor applied to them. This inflation factor is based on the borrower's best judgment. Whatever annually compounded rate(s) is chosen, it should be noted in the study for the reviewer's benefit.

4.4 Annual Charge Factors

4.41 The annual charge factors represent the annual cost of operating and maintaining the item as a percentage of the original (first) cost.

4.42 Because each class of equipment varies in operating and maintenance costs and from company to company, no common value can be assigned. Rather, it is necessary to develop individual annual charge factors for each item.

4.43 The total annual charge factor is made up of the sum of six components each of which must be calculated separately. The six components are as follows:

A. Cost of Money
B. Depreciation
C. Income Tax
D. Property Tax
E. Maintenance
F. Other Administration

4.44 The following table lists common items appearing in economic studies and the annual charge components that apply to them.

Item	Cost of Money	Depreciation	Inc. Tax	Prop. Tax	Maintenance	Other Admin.
A. New Plant	X	X	X	X	X	As Needed
B. Retained Plant (Not Fully Depreciated)	X	X	X	X	X	As Needed
C. Retained Depreciated Plant				X	X	As Needed
D. Retired Plant (Fully Depreciated)				X	X	As Needed
E. Pre-mature Retirement	X	X	X			As Needed
F. Removal (Future)	X		X			As Needed
G. Salvage (Future)	X		X			As Needed
H. Cash Payments	X		X			As Needed
I. Nonrecurring Costs	X		X			As Needed
J. Removal (Current)	No Annual Charge – One Time Charge at Start of Plan					
K. Salvage (Current)	No Annual Charge – One Time Charge at Start of Plan					

4.45 The annual charge factor is always a positive number. The resultant annual charge can be positive (cost) or negative (credit) for each item depending on whether the unit cost is a positive or negative number.

4.46 The total annual charge for each year is the algebraic sum of all the individual annual charges for that year.

4.5 <u>Cost of Money</u>

4.51 The cost of money is a weighted composite value dependent on the cost of debt, return on equity and the debt to equity ratio. TE & CM Section 219, paragraphs 2.4 to 2.45 illustrate how to calculate the cost of money.

4.52 An additional point to remember concerning cooperative enterprises is that the cost of borrowed capital is not the only factor in determining their cost of money. Even though they do not issue common stock as in a commercial corporation, they do have equity and should earn a return on that equity.

4.53 For a cooperative its equity is the sum of the capital credits and retained earnings which is total net worth (line 29 of the REA Annual Report). Net Income (line 56 of the report) divided by total net worth is the return on equity.

4.54 The cost of money when calculated generally does not result in a whole number values such as 6, 7, 8, 9 percent, etc. This presents a problem of what to do when an intermediate value is calculated such as 6.3 percent, 7.6 percent, etc., when the interest tables are published in whole number increments.

4.55 The most accurate way to proceed is to calculate the required present worth value at the particular cost of money rate using the formulas given in the interest tables. With the various calculators and computer programs available this is not a difficult process.

4.56 A straight line interpolation between whole number tables is acceptable if the borrower chooses not to attempt the formula calculation.

4.561 For comparable line items being implemented in the same time frame using straight line interpolation, there would be no relative difference between plans, only a magnitude change.

4.562 For comparable line items being implemented at different times using straight line interpolation would result in a maximum relative difference of less then 2 percent for a time differential of 20 years. This relative differential is less in most cases and certainly would not be a determining factor in selecting a particular plan.

4.6 Depreciation

4.61 Depreciation is the lowering of the estimated value of an item of plant because of age, obsolescence, wear and tear or other factors.

4.62 Depreciation reserve is the amount of money required to be accumulated over a specified period of time to recover the original capital invested less the salvage value. In the remainder of this section when depreciation is mentioned, it will be understood to mean depreciation reserve.

4.63 All engineering economic studies by REA borrowers must use sinking fund depreciation factors. These factors are also known as annuity for future amount factors in many versions of the standard interest tables.

4.64 The method of calculating sinking fund depreciation plus the cost of money provides the same total cost effect as the accounting method of declining book value interest payment plus straight line depreciation. For those interested in a full discussion of this equality, refer to Chapter Six in "Engineering Economics", by Ollie Smidt and published by Telephony.

4.641 Use sinking fund depreciation factors coupled with the cost of money because it is easier to determine these values than to determine declining book values.

4.65 The sinking fund depreciation factor is determined by the interest rate and the service life of the item.

4.651 The interest rate is the cost of money used in the study.

4.652 Most items of equipment have well-known and accepted service lives and some of these can be found in TE & CM Section 219.

4.653 The service life for digital switching equipment has been subject to various interpretations. Because there is limited available field data on digital switching at this time, an interim maximum service life of 20 years for digital switches is required in all engineering economic studies for REA borrowers. If a borrower chooses a shorter service life, that is acceptable to the REA.

4.654 The service life of an item of equipment can be shortened because of premature retirement.

4.655 When equipment additions are proposed and it is planned to completely retire an item of equipment before its normal full depreciation, a shortened service life will be used for the additions.

4.656 The service life for a planned premature retirement will be equal to the time between installation and the planned retirement. A sinking fund depreciation rate corresponding to this time interval is used. For example, a new S x S addition if it lasted its normal service life of 25 years

at a six percent cost of money would have a sinking fund depreciation factor of 1.8 percent. However, if the same addition is planned to be retired in five years, the sinking fund factor is now 23.7 percent.

4.7 Income Tax

4.71 Income tax is a capital cost of doing business for commercial corporations. The remaining income after deducting expenses and the cost of debt is divided between income taxes and return on equity.

4.72 There is a detailed formula for calculating the true income tax rate for each class of equipment in Chapter Seven of "Engineering Economics". For those with programmable calculators or computer programs, this is a useful formula to consider using.

4.73 Engineering economic studies are only concerned with differences in plans, so simpler methods of deriving income tax factors are acceptable.

4.731 An acceptable simplified version of the income tax formula does not include tax deductions due to salvage or depreciation. This simplified formula is as follows:

$$T_{ac} = \frac{T_r}{1-T_r} (W_e)$$

$W_e = (1-D_r)(R_e)$
T_{ac} = Income Tax Annual Charge Factor
T_r = Federal Income Tax Rate
W_e = Weighted Cost of Equity Capital
R_e = Return on Equity
D_r = Debt Ratio = $\frac{\text{Debt}}{\text{Debt + Equity}}$

By using this formula we overstate the amount of income tax due. However, comparable line items in the economic studies usually have the same service life and sometimes the same salvage. In these cases, the differences are zero. In a case where the salvage difference is as much as 25 percent, the differences in tax factors would be less than ½ percent, which is sufficiently accurate especially when only some of the comparable line items would be affected.

4.75 Another method is to use the actual tax rate paid as obtained from the company's records. This rate would be a composite average for all plant, but the magnitude would be more accurate because all deductions for salvage and service life have been accounted for. For the same reasons as above the differences in line items are relatively small, so this method is acceptable.

4.8 Property Tax

4.81 There is no general method for determining the property tax for each class of equipment because the local tax structures vary so widely.

4.82 From the company's records divide the property taxes paid by the book value of the plant for each exchange and this will be the annual charge rate for property tax.

4.9 Maintenance

4.91 Maintenance is all the costs involved in keeping the plant in normal operating condition.

4.92 The maintenance annual charge factor is the sum of all these costs divided by the total cost of the plant equipment being maintained.

4.93 These costs for maintenance are derived from the company's historical records.

4.94 Because there is no historical data on maintenance for digital switching available at this time, an interim standard is recommended for the digital equipment maintenance annual charge factor.

4.941 Until proper data is available, all engineering economic studies done for REA borrowers should use a maintenance annual charge factor no lower than that would be used for a new S x S switch or for the present S x S switch if it is in good condition.

4.942 If some local condition justifies a higher than normal maintenance factor for the present S x S switch, a lower maintenance annual charge factor will be allowed for the digital switch but in no case less than 4 percent.

4.943 The effect of this interim standard will be to help insure that a digital switch will not be proposed based on an assumed reduced maintenance cost for its justification.

4.10 Other Administrative Factors

4.101 Other administrative factors such as insurance, traffic costs, or overhead should be included as an annual charge factor as needed for appropriate line items.

4.11 Present Worth Factors

4.111 The ultimate objective of engineering economic studies is to find the total present worth of each competing plan.

4.112 In studies involving equipment for which annual charge factors can be developed, the total present worth is the sum of all the PWAC amounts. The development of PWAC amounts is illustrated in TE & CM Section 219 and will not be repeated. It is suggested, however, that the method of using a deferred annuity be reviewed as this is a common cause of error.

4.113 Some studies involve cash payments or settlements for which annual charge factors cannot be developed, so a different method of determining its present worth is required. In these cases, the total present worth of the plan is the sum of the PWAC values for the equipment items and the present worth of the cash payments.

4.114 These cash settlements usually are single payment items such as sale of property or recurring payments such as LAMA settlements.

4.115 For a single cash payment item finding the present worth is a simple mathematical multiplication by the appropriate present worth of a single payment factor (p/f) from the interest tables. A sample calculation for an 8 percent cost of money case follows below:

(A)	(B)	(C)	(B x C)
Year of Payment	Payment	(p/f) Factor	Present Worth
6	$10,000	.6302	$6,302

4.116 For the case of recurring payments finding the present worth is merely repeating the calculation process above as many times as necessary and finding the total sum. Before the calculations can be made, the borrower must estimate the value of the payment expected per year. A sample process is shown below:

> Problem: A borrower will institute LAMA ticketing in plan year 4 with the introduction of the digital switch. Initially, the LAMA settlements will be $10,000 based on the number of calls processed. The number of calls is estimated to grow at 6 percent per year. Determine the present worth of LAMA ticketing over the 20 year plan time period at 8 percent cost of money.

(A) Payment Year	(B) Payment	(C) (p/f) Factor	(B x C) Present Worth
0	$ 0	1.0000	$ 0
1	$ 0	.9259	$ 0
2	$ 0	.8573	$ 0
3	$ 0	.7938	$ 0
4	$10,000	.7350	$7,350
5	$10,600	.6806	$7,214
6	$11,236	.6302	$7,081
7	$11,910	.5835	$6,949
8	$12,625	.5403	$6,821
9	$13,382	.5002	$6,694
10	$14,185	.4632	$6,570
11	$15,036	.4289	$6,449
12	$15,938	.3971	$6,329
13	$16,895	.3677	$6,212
14	$17,908	.3405	$6,098
15	$18,983	.3152	$5,983
16	$20,122	.2919	$5,874
17	$21,329	.2703	$5,765
18	$22,609	.2502	$5,657
19	$23,965	.2317	$5,553
20	$25,404	.2145	$5,449

LAMA Present Worth = $108,048

4.117 The above process for finding the total present worth of cash settlements is admittedly long and tedious, but for accuracy no easier method is available.

4.118 A proposed short-cut method is not acceptable to REA for central office replacement studies because it overstates the case for the digital switch.

The short-cut method proposed is:

1. Find the average annual payment;
2. Multiply by the appropriate present worth factor.

For the preceding example the average annual payment would be $16,596 multiplied by 7.241 (PWAC factor for an annuity deferred 3 years) for a proposed present worth of $120,172 which is an 11.2 percent overstatement of the correct present worth. This level of difference is unacceptable.

4.119 This short-cut method of calculating the present worth of cash payments would only be acceptable when the borrower can prove satisfactorily that the preferential relationship between competing plans is unchanged by any error in the present worth of the cash payments.

5. STUDY FORMATS

5.1 General

5.11 The exact format of how to present an economic study is not important. What is important is that it clearly presents to the reviewers all the critical components used in preparing the study.

5.12 These critical components have been discussed in the previous sections, but will be summarized here to re-emphasize the point.

COMPONENT	TYPE OF STUDY			
	PWAC	AC	PWFC	FC
Major Line Items	X	X	X	X
Unit Cost	X	X	X	X
Quantity Required	X	X	X	X
First Cost by Line Item	X	X	X	X
Total First Cost	X	X	X	X
PWFC Factor	Opt.	Opt.	X	N.R.
Total PWFC	Opt.	Opt.	X	N.R.
Annual Charge Factor Details	X	X	N.R.	N.R.
Total Annual Charge Factor by Class	X	X	N.R.	N.R.
Annual Charges by Line Item	X	X	N.R.	N.R.
Total Annual Charges	X	X	N.R.	N.R.
PWAC Factor by Line Item	X	N.R.	N.R.	N.R.
PWAC by Line Item	X	N.R.	N.R.	N.R.
Total PWAC	X	N.R.	N.R.	N.R.

Opt. = Optional N.R. = Not Required

5.2 Typical Formats

5.21 The following exhibits are formats used most often in economic studies.

5.22 Exhibit 1 is a format patterned after the studies in "Engineering Economics". This format is excellent and when properly filled in presents all the data necessary for a PWAC study.

5.23 Exhibit 2 is another format in use and it has everything needed for a PWAC study. If only a PWFC or AC study was involved, this form would be insufficient.

EXHIBIT 1

COMPANY ______________________

PROJECT NO. __________

ECONOMIC SELECTION STUDY

DESCRIPTION: ______________________________

PLAN _____ OF _____ SHEET _____ OF _____
PREPARED BY ______________ DATE _________
STUDY PERIOD ______________________

		CAPITAL REQUIREMENTS					REVENUE REQUIREMENT				
		FIRST COST		PRESENT WORTH OF FIRST COST			ANNUAL COST		PRES. WRTH. AN. COST		
ITEM A	QUANTITY B	UNIT COST C	AMOUNT D (BXC)	DATE OF EXPEN. E	FACTOR F	AMOUNT G (DXF)	PERCENT H	AMOUNT I (DXH)	PERIOD J	FACTOR K	AMOUNT L(IXK)
TOTALS											

REMARKS:

TYPE OF PLANT					
COST OF MONEY					
PROPERTY TAX					
INCOME TAX					
DEPRECIATION					
MAINTENANCE					
OTHER					
TOTAL					

EXHIBIT 2

PWAC STUDY

PLAN ______________________

No.	Description (1)	Installed First Cost (2)	Year (3)	Life (4)	Sal-vage (5)	Cost of Money (6)	S. F. Depre. (7)	Maint. (8)	Misc. An. Ch. (9)	PWAC Fac. (10)	See Note PWAC (11)

Study Period ______________ Years

Interest Rate ______________

Number of Entries ______________

Total First Costs ______________

PWAC ______________

Annual Charge ______________

RECOMMEND ______________

Miscellaneous Annual Charges - Estimated

Telephone Company's Overhead =
Insurance =
Income Tax =
Property Tax = ______

TOTAL =

Note: PWAC (11) = (2-5) x (6+7+8+9) x (10)

6. SAMPLE STUDIES

6.1 Types of Samples

The types of economic studies prepared generally fall into one of three types i.e., the conventional format used in Ollie Smidt's book, a computerized format or a fill-in-the-blank format. Each method has its advantages to the preparer depending on the volume of studies processed and the skill level required. Any of these formats are satisfactory to the REA as long as at least the minimum amount of information required is included for review by the REA. Any other type of format that includes the required information that might be devised by the borrower is also satisfactory. Whatever type of presentation that fits the borrower's engineering style and the project proposed is the format that should be used.

6.2 Sample Formats

The attached appendices include one sample of each of the predominate types of formats. These samples were prepared by three different borrowers and their consulting engineers. The identification has been changed and only those parts of the study related to the economic selection process have been included. A note of caution to be observed is that these studies are shown as samples to be used as a starting point reference only. Each borrower would have to modify, add or subtract items as they apply to his proposed project.

6.21 Appendix I is a sample in the conventional format. Appendix II is a sample computerized printout format. Appendix III is a fill-in-the-blank type of format.

APPENDIX I

Gainsville Telephone Company

Analysis - Cost Study - COE

Time Frame

	1982	1987	1992	1997	2002
Plan I - Cumulative Investment	686,000	1,230,800	2,129,800	3,043,400	4,029,600
Plan II - Cumulative Investment	770,000	1,100,000	1,581,500	2,130,200	2,952,800
Plan I - P.W.F.C.	686,000	1,056,790	1,473,206	1,761,174	1,972,714
Plan II - P.W.F.C.	770,000	994,602	1,217,354	1,390,305	1,566,753
Plan I - PWAC	1,468,272	2,198,160	2,887,154	3,274,573	3,443,832
Plan II - PWAC	1,648,070	2,090,185	2,472,966	2,705,648	2,846,829

Conclusion:

Although Plan II is $84,000 more costly in initial time frame (SLP - 5 year 1982) it quickly becomes the least expensive plan when viewed in 1987 and beyond. Conversion to common control should be considered now for the Gainsville Exchange.

Cainsville Telephone Company

COE Cost Comparison (Common Control vrs. XY Step)

Plan I - Continue to expand all exchanges with A/B XY step using refurbished equipment.

Plan II - Change Cainsville Exchange to Common Control Equipment and reuse the existing A/B XY step from Cainsville for expansion of other exchanges.

Station Projection Per REA Forms 569

	Existing	Proposed				
	6/77	6/82	6/87	6/92	6/97	6/02
Cainsville	2225	2825	3425	4025	4625	5225
Mercury	261	331	401	471	541	611
Westedgeville	815	995	1175	1355	1535	1715
Murook	893	1393	1893	2393	2893	3393

COE Requirements Based on Above Station Projection and Considering "Other" Subscribers, Test and Space (Lines/Terminals)

Cainsville	1700/2900	3000/3200	3600/3900	4300/4700	4800/5200	5400/6000
Mercury	200/300	400/400	500/500	500/600	600/700	700/700
Westedgeville	600/900	1100/1100	1300/1300	1500/1600	1600/1700	1800/1900
Murook	700/900	1500/1500	2000/2200	2500/2800	3000/3300	3500/3900

Estimating Prices COE & Building

	Time Frame of Purchase				
Type of Equipment	6/82	6/87	6/92	6/97	6/02
New Common Control	$235/L	$282/L	$338/L	$406/L	$487/L
Refurbished A/B XY Step	180/L 140/T	216/L 168/T	259/L 202/T	311/L 242/T	373/L 290/T
Reused A/B XY Step From Cainsville	30/L 20/T	36/L 24/T	43/L 29/T	52/L 35/T	62/L 42/T
Bldg. Addition	$ 75/ft.	$ 90/ft.	$108/ft.	$130/ft.	$156/ft.

The above cost have been increased at the rate of 4% per year for inflation based on the starting time frame of 1982.

Gainsville Telephone Company

Cost Study - COE

		1982 Estimated Cost	Initial-P.W. 8%
Plan I			
Gainsville	- 1982 - Add 1300L/300T	$ 276,000	$ 276,000
	- 1987 - Add 600L/700T	247,200	168,244
	- 1992 - Add 700L/800T	342,900	158,831
	- 1992 - Add Bldg. 40' x 40'	172,800	80,041
	- 1997 - Add 500L/500T	276,500	87,153
	- 1997 - Add New Rank Interim Sel.	250,000	78,800
	- 2002 - Add 600L/800T	455,800	97,769
Mercury	- 1982 - Add 200L/100T	50,000	50,000
	- 1987 - Add 100L/100T	38,400	26,135
	- 1992 - Add -- /100T	20,200	9,357
	- 1997 - Add 100L/100T	55,300	17,431
	- 2002 - Add 100L/ --	37,300	8,001
Westedgeville	- 1982 - Add 500L/300T	132,000	132,000
	- 1987 - Add 200L/200T	33,600	22,868
	- 1992 - Add 200L/300T	112,400	52,063
	- 1997 - Add 100L/100T	55,300	17,431
	- 2002 - Add 200L/200T	132,600	28,443
Murock	- 1982 - Add 800L/600T	228,000	228,000
	- 1987 - Add 500L/700T	225,600	153,543
	- 1992 - Add 500L/600T	250,700	116,124
	- 1997 - Add 500L/500T	276,500	87,153
	- 2002 - Add 500L/600T	360,500	77,327

Cainsville Telephone Company

Cost Study - COE

Plan II

			1982 Initial-P.W. 8% Estimated Cost
Cainsville	- 1982 - Add New Comm. Cont. 3000L	$ 705,000	$ 705,000
	- 1987 - Add Comm. Cont. 600L	169,200	115,158
	- 1992 - Add Comm. Cont. 700L	236,600	109,315
	- 1997 - Add Comm. Cont. 500L	203,000	63,986
	- 2002 - Add Comm. Cont. 600L	292,200	62,677
Mercury	- 1982 - Add 200L/100T (Reused)	8,000	8,000
	- 1987 - Add 100L/100T (Reused)	6,000	4,084
	- 1992 - Add -- /100T (Reused)	2,900	1,343
	- 1997 - Add 100L/100T (Reuse (T))	34,600	10,906
	- 2002 - Add 100L/ --	37,300	8,001
Westedgeville	- 1982 - Add 500L/300T (Reused)	21,000	21,000
	- 1987 - Add 200L/200T (Reuse (T))	48,000	32,672
	- 1992 - Add 200L/200T	92,200	42,707
	- 1992 - Add -- /100T (Reused)	2,900	1,343
	- 1997 - Add 100L/100T	34,600	10,906
	- 2002 - Add 200L/200T	132,600	28,443
Murook	- 1982 - Add 800L/600T (Reused)	36,000	36,000
	- 1987 - Add 100L/700T (Reused)	20,400	13,884
	- 1987 - Add 400L/ --	86,400	58,804
	- 1992 - Add -- /600T (Reused)	17,400	8,060
	- 1992 - Add 500L/ --	129,500	59,984
	- 1997 - Add 500L/500T	276,500	87,153
	- 2002 - Add 500L/600T	360,500	77,327

CAINSVILLE TELEPHONE COMPANY

REA PROJECT NO. ____________

DESCRIPTION: PLAN I - Continue to expand all exchanges with a/b xy step using refurbished equipment.

PLAN I OF II SHEET 1 OF 2
PREP. BY ______ DATE 12/77
STUDY PERIOD THROUGH 2007

ECONOMIC SELECTION STUDY

ITEM A	QUANTITY B	CAPITAL REQUIREMENTS: FIRST COST: UNIT COST C	FIRST COST: AMOUNT D(B X C)	PRESENT WORTH OF FIRST COST: DATE OF EX E	FACTOR F	AMOUNT G(D X F)	REVENUE REQUIREMENT: ANNUAL COST: PERCENT H	AMOUNT I(D X H)	PRESENT WORTH OF ANNUAL COST: PERIOD J	FACTOR K	AMOUNT L(I X K)
Add Step Equipment	2800L	PER ATTACHED	686,000	1982	1.0000	686,000	20.05%	137,543	25 YRS	10.675	1,468,272
Add Step Equipment	1400L		544,800	1987	0.6806	370,790	20.05%	109,232	20 YRS	6.682	729,888
Add Step Equipment	1400L		726,200	1992	0.4632	336,375	20.05%	145,603	15 YRS	3.965	577,316
Add Building	40'x40'		172,800	1992	0.4632	80,041	16.3 %	28,166	15 YRS	3.965	111,678
Add Step Equipment	1200L		663,600	1997	0.3152	209,168	20.05%	133,052	10 YRS	2.115	281,405
Add Interim Selectors	As Req'd		250,000	1997	0.3152	78,800	20.05%	50,125	10 YRS	2.115	106,014
Add Step Equipment	1400L		986,200	2002	0.2145	211,540	20.05%	197,733	5 YRS	0.856	169,259
TOTALS			4,029,600			1,972,714		* 801,454			3,443,832

* Annual cost of period 2002-2007

REMARKS: Factors (K) 8%

25 YRS - (10.675) (1.0000) = 10.675
20 YRS - (9.818) (0.6806) = 6.682
15 YRS - (8.559) (0.4632) = 3.965
10 YRS - (6.710) (0.3152) = 2.115
5 YRS - (3.993) (0.2145) = 0.856

	NON-STANDARD ANNUAL PERCENTAGES (1)	(2)	(3)	(4)	(5)
TYPE OF PLANT	Step-COE	Elect.-COE	Building		
COST OF MONEY	8%	8%	8%		
PROPERTY TAX	3.85%	3.85%	3.85%		
INCOME TAX	-0-	-0-	-0-		
DEPRECIATION	4.5 %	4.5 %	2.7 %		
MAINTENANCE	3.7 %	3.7 %	1.75%		
TOTAL	20.05%	20.05%	16.3 %		

CAINSVILLE TELEPHONE COMPANY

REA PROJECT NO. ______

DESCRIPTION: PLAN II - Change Cainsville Exchange to Common Control Equipment and reuse the existing a/b xy step from Cainsville for expansion of other exchanges.

PLAN II OF II SHEET 2 OF 2
PREP. BY ______ DATE 12/77
STUDY PERIOD THROUGH 2007

ECONOMIC SELECTION STUDY

ITEM	CAPITAL REQUIREMENTS						REVENUE REQUIREMENT				
		FIRST COST		PRESENT WORTH OF FIRST COST			ANNUAL COST		PRESENT WORTH OF ANNUAL COST		
ITEM A	QUANTITY B	UNIT COST C	AMOUNT D(B X C)	DATE OF EX. E	FACTOR F	AMOUNT G(D X F)	PERCENT H	AMOUNT I(D X H)	PERIOD J	FACTOR K	AMOUNT L(I X K)
Add New Office	3000L		705,000	1982	1.0000	705,000	20.05%	141,353	25 YRS	10.675	1,508,943
Add Step Equipment	1500L		65,000	1982	1.0000	65,000	20.05%	13,033	25 YRS	10.675	139,127
Add Step Equipment	800L	PER ATTACHED	160,800	1987	0.6806	109,444	20.05%	32,240	20 YRS	6.682	215,428
Add Elect. Equipment	600L		169,200	1987	0.6806	115,158	20.05%	33,925	20 YRS	6.682	226,687
Add Elect. Equipment	700L		236,600	1992	0.4632	109,315	20.05%	47,438	15 YRS	3.965	188,092
Add Step Equipment	700L		244,900	1992	0.4632	113,437	20.05%	49,102	15 YRS	3.965	194,689
Add Step Equipment	700L		345,700	1997	0.3152	108,965	20.05%	69,313	10 YRS	2.115	146,597
Add Elect. Equipment	500L		203,000	1997	0.3152	63,986	20.05%	40,702	10 YRS	2.115	86,085
Add Elect. Equipment	600L		292,200	2002	0.2145	62,677	20.05%	58,586	5 YRS	0.856	50,150
Add Step Equipment	800L		530,400	2002	0.2145	113,771	20.05%	106,345	5 YRS	0.856	91,031
TOTALS			2,952,800			1,566,753		* 592,037			2,846,829

* Annual cost of period 2002-2007

REMARKS: FACTORS (K) 8%

SEE SHEET 1 OF 2

	NON-STANDARD ANNUAL PERCENTAGES				
	(1)	(2)	(3)	(4)	(5)
TYPE OF PLANT					
COST OF MONEY					
PROPERTY TAX		SEE SHEET 1 OF 2			
INCOME TAX					
DEPRECIATION					
MAINTENANCE					
TOTAL					

APPENDIX II

PWAC Study Outline

I. Company Proposal

The Company desires to replace the magneto switch with an atomic switch. Four of the nine Board Members wants to do so in 1979. Four want to do so in 1985. The President on the advise of the Consulting Engineer and REA Field Staff suggests making an economic analysis of the two alternate plans.

II. Existing Situation

The East Overshoe exchange is a 500 line magneto operation with 5 operators. Total operator wages and overheads are $64,999 per year. Existing debit is $130,000. Existing equity is $80,000.

Growth conditions will require an addition of 100 drops in 1979 and one more operator.

In 1983 another 100 drops will be required plus operator wage increases and the addition of one more operator.

The existing Board is depreciated to -0- dollars; the existing switchboard room is full. A building addition will be required; however, site space is very limited. The building is depreciated to -0- dollars.

An addition to the building of sufficient space to allow growth through 1985 is estimated at $5,000.

Immediate salvage values appear to be:

Land and Building	$7,500
Switch Board	$500

Drop positions are estimated to cost $100 each in 1979 with inflationary increase to $125 each in 1983.

Since building space is limited and the old building is not adequate to house a new switch, a location move is necessary. New land is available now for $7,000. Inflationary increased of the area indicate the land will increase to $8,000 by 1984.

An adequate 30 year building is estimated at $30,000.

The new switch (600 lines) is estimated at $200,000. Additions are expected to remain stable in price through the planning period.

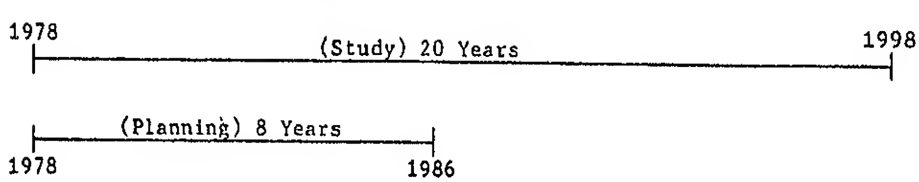
Annual Charge Factors for this company are

Switch Maintenance	5.0%
Advalorem Tax	2.0%
Income Tax	3.07%
Building Maintenance	2.0%
Cost of Money	10.73%

Requirements

	Magneto	Atomic	Total
1978	500		500
1979	+100	600	600
1980	---	---	
1981	---	---	
1982	---	---	
1983	+100	+100	700
1984	---	---	
1985	XXX	+100	800

Plan & Study Periods



PWAC DATA REQUEST

COMPANY NAME & ADDRESS: ____

PHONE NUMBER: ________________ MANAGER: ____________________________

NAME OF EXCHANGE TO BE STUDIED: ___________________________________

System Financial Totals:

- Total Dollars Of Plant In Service $______________
- Total Depreciation Reserve $______________
- Total Amount Presently Borrowed $______________
- Interest Rate On Amount Borrowed ______%
- Dollars Of Equity In System $______________
- Dollars Of Profit Or Margins Last Year $______________
- Does The Company Pay Federal Income Taxes Yes____ No____

Data On Exchange To Be Studied:

Existing Central Office Equipment

Prefix __________ Brand __________

Total COE Investment In This Exchange As Of Years Ending:

	Number of Lines Equipped	Year	Amount
Year of Orig. Installation	______	______	$______
	______	1955	______
	______	1960	______
	______	1965	______
	______	1970	______
	______	1975	______
	______	1977	______

Total Cost Of Central Office Equipment: $______
Total Depreciation To Date Of This COE: $______
Depreciation Rate (Annual %) ______%
Maintenance Expense (Previous 12 Mo. Period): $______

Present No. of Line TPS ________ Present No. of Lines TPL ________
Present No. of Terminals ________ Loop Limits of COE ________
Age and Amp/Hour Capacity of Batteries ______________
Age and Size of Charger(s) ______________ Single or Three Phase AC ________
Is Tone Dial Equipment in Use Yes ____ Quantity ____ No ____
Line Treatment: Common Mode Operation Yes ____ Quantity ____ No ____
No. of Local Service VF Repeaters ____ No. of Loop Extenders ____
Is COE Grounding Adequate Yes____ No ____

Are There Any Known Traffic Problems? Yes ____ Describe: ______________

____

____ No ____

Existing Office Continued:

Type of MDF ______________________________

No. of and Type of Protectors on MDF ______________________________

Attach a Copy of Current CDO Building Floor Plan.

Attach a Copy of Switching Trunking Diagram with Correct Equipment Quantities.

Number of Main Stations In Exchange:		Key System Lines	PBX Lines
1971	______		
1972	______		
1973	______		
1974	______		
1975	______		
1976	______		
1977	______		
Present	______	______	______
1983 Estimated	______	______	______

Planning Proposals

If feasible, we would like a new COE in Service in 19 ____.

If feasible, we would prefer a new CDO building Yes ____ No ____

We have already obtained quotations for a new central office Yes ____ No ____
If Yes list Supplier and Amount:

Estimate what number of your subscribers who might take the following custom calling services:

____ Call Waiting
____ Call Transfer
____ 3 Way Calling
____ Abbreviated Dialing

Present Worth of Annual Charge Analysis

Project No. D.C. 500 | Exchange East Overshoe
Work Code ______ | Plan Designation A 1
Cost of Money 0.1073 % | Study Period 20 Years

Plan Description: (Brief) "Control Plan"
Replace magneto switch with atomic switch in 1979.

Item Descriptions	Item	Item Category	Year Of Investment	Initial Investment Amount	Life Years
1.	New Land	L	1978	7,000	--
2.	New Building	B	1978	30,000	30
3.	New Atomic Switch	EC	1979	200,000	20
4.	Retire Old Land and Building	RB	1979	-0-	--
5.	Salvage Old Land and Building	SB	1979	-7,500	--
6.	Retire Old Switch	RC	1979	-0-	--
7.	Salvage Old Switch	SC	1979	-500	--
8.	Credit Opr. Wages	CC	1980	-72,149	--
9.	Credit Custom Call (Net)	CC	1980	-5,000	--
10.	Add 100 Atomic Ports	EC	1983	20,000	15
11.	Credit Custom Call (Net)	CC	1983	-1,500	--
12.	Credit Opr. Wages	CC	1983	-8,000	--
13.	Add 100 Atomic Ports	EC	1983	20,000	10
14.					
15.					
16.					

Annual Charges	Mechanical COE	Electronic COE	Buildings	Outside Plant	Electronic Equip.
Maintenance	5.0	5.0	2.0		
Ad Valorem Tax	2.0	2.0	2.0		
Income Tax	3.07	3.07	3.07		
Gross Receipts Tax	----	----	----		

Cost of Money:

Interest Rate x % Debt .08 x .61

Return x % Equity .15 x .39

Debt $130,000
Equity $80,000
Total 10.73%

ABBREVIATIONS

OP = Outside Plant
RO = Retire OP
SO = Salvage OP

B = Buildings
RB = Retire Bldgs.
SB = Salvage Bldgs.
L = Land

EE = Elec. Eq.
RE = Retire EE
SE = Salvage EE
CC - Capital Credit

MC = Mech. COE
EC = Elec. COE
RC = Retire COE
SC = Salvage COE

Present Worth of Annual Charge Analysis

Project No. D.C. 500 Exchange East Overshoe
Work Code ______ Plan Designation B 1
Cost of Money 0.1073 % Study Period 20 Years

Plan Description: (Brief)

Add to magneto switch until 1985.

Item Descriptions	Item	Item Category	Year Of Investment	Initial Investment Amount	Life Years
1.	Building Addition	B	1978	5,000	7
2.	Add 100 Drops	MC	1979	10,000	6
3.	Add 100 Drops	MC	1983	12,500	2
4.	New Land	L	1984	8,000	30
5.	New Building	B	1984	36,000	30
6.	New Atomic Switch	EC	1985	240,000	20
7.	Retire Old Land and Building	RB	1985	-2,333	--
8.	Salvage Old Land and Building	SB	1985	-10,000	--
9.	Retire Old Switch	RC	1985	-14,000	--
10.	Salvage Old Switch	SC	1985	-500	--
11.	Credit Opr. Wages	CC	1985	-80,149	--
12.	Credit Custom Call (Net)	CC	1985	-6,500	--
13.					
14.					
15.					
16.					

Annual Charges	Mechanical COE	Electronic COE	Buildings	Outside Plant	Electronic Equip.
Maintenance					
Ad Valorem Tax					
Income Tax					
Gross Receipts Tax					

Cost of Money:

Interest Rate x % Debt ______ x ______

Return x % Equity ______ x ______ Total ______

	OP = Outside Plant	B = Buildings	EE = Elec. Eq.	MC = Mech. COE
	RO = Retire OP	RB = Retire Bldgs.	RE = Retire EE	EC = Elec. COE
	SO = Salvage OP	SB = Salvage Bldgs.	SE = Salvage EE	RC = Retire COE
		L = Land	CC = Cap. Credit	SC = Salvage COE

****

PRESENT WORTH OF ANNUAL CHARGE ANALYSIS

PROJECT NUMEER DC 500
EXCHANGE: EAST OVERSHOE PLAN A1 DATE OF RUN 04-20-78 COST OF MONEY .1073 STUDY PERIOD 20 YEARS

PLAN DESCRIPTION; REPLACE MAGNETO SWITCH WITH ATOMIC SWITCH IN 1979

	CAPITOL REQUIREMENTS FIRST COST		PRESENT WORTH FC		REVENUE REQUIREMENTS ANNUAL COSTS					PRESENT WORTH ANNUAL COST		
NO, CATAGORY, ITEM	AMOUNT	YEAR	PWF	AMOUNT	SFD%	TOT%	AMOUNT	GRT	OPM	LIFE	PW/A	AMOUNT
1 L NEW LAND	$7000	1978	1.000	$7000	0.00	2.00	$140	$0	$0	30	8.106	$1135
2 B NEW ELDG	$30000	1978	1.000	$30000	0.50	18.30	$5490	$0	$0	30	8.106	$44502
3 EC NEW ATOMIC SWITCH	$200000	1979	0.903	$180600	1.60	22.40	$44800	$0	$0	20	7.203	$322694
4 RB RETIRE OLD L & BLDG	$0	1979	0.903	$0	0.00	4.00	-$0	$0	$0	19	7.203	$0
5 SB SALVAGE OLD L & BLDG	-$7500	1979	0.903	-$6772	0.00	13.80	-$1035	$0	$0	19	7.203	-$7455
6 RC RETIRE OLD SWITCH	$0	1979	0.903	$0	0.00	2.00	-$10000	$0	$0	19	7.203	-$72030
7 SC SALVAGE OLD SWITCH	-$500	1979	0.903	-$451	0.00	13.80	-$69	$0	$0	19	7.203	-$497
8 CC CREDIT OPR WAGES	$0	1980	0.000	$0	0.00	0.00	-$72149	$0	$0	18	6.387	-$460816
9 CC CREDIT CUSTOM CALL (NET)	$0	1980	0.000	$0	0.00	0.00	-$5000	$0	$0	18	6.387	-$31935
10 EC ADD 100 ATOMIC PORTS	$20000	1983	0.601	$12020	3.00	23.80	$4760	$0	$0	15	4.385	$20873
11 CC CREDIT CUSTOM CALL (NET)	$0	1983	0.000	$0	0.00	0.00	-$1500	$0	$0	15	4.385	-$6578
12 CC CREDIT OPR WAGES	$0	1983	0.000	$0	0.00	0.00	-$8000	$0	$0	15	4.385	-$35080
13 EC ADD 100 ATOMIC PORTS	$20000	1985	0.490	$9800	6.10	26.90	$5380	$0	$0	10	2.918	$15699

****

ANNUAL MAINT. ON ITEM 6 IS $10000 TOTAL PRESENT WORTH OF ANNUAL COSTS -$209433
EQUATED ANNUAL CHARGES -$25767

ANNUAL CHARGES SUMMARY FOR DC 500

	MECH. COE	ELECTRONIC COE	BLDGS	OUTSIDE PLANT	ELECTRONIC EQUIP
MAINTENCE	5.00	5.00	2.00	0.00	0.00
AD VALOREM TAX	2.00	2.00	2.00	0.00	0.00
INCOME TAX	3.07	3.07	3.07	0.00	0.00
GROSS RECEIPTS TAX	0.00	0.00	0.00	0.00	0.00
COST OF MONEY	10.73	10.73	10.73	10.73	10.73

NOTES:
1. SFD. = SINKING FUND DEPRECIATION
2. ANNUAL CHARGES ON RETIREMENTS = MAINTENCE + PROPERTY TAXES
   Maint is calculated to be equal on the old and new switch at the time of retirement
3. ANNUAL CHARGES ON SALVAGE = COST OF MONEY + INCOME TAXES
4. PW/A = FACTOR FOR PRESENT WORTH OF AN ANNUITY (PWAC)
5. COST OF MONEY = %RETURN X %EQUITY + %INTEREST X %DEBT
6. GRT = GROSS RECEIPTS TAX ON REVENUE WHERE APPLICABLE
7. OPM = OUTSIDE PLANT MAINTENANCE AT $ 0 /MILE
8. IF THE LIFE OF AN ITEM EXCEEDS THE STUDY PERIOD IT IS DEFAULTED TO THE END OF THE STUDY PERIOD.

****

PRESENT WORTH OF ANNUAL CHARGE ANALYSIS

PROJECT NUMBER DC 500
EXCHANGE: EAST OVERSHOE PLAN B1 DATE OF RUN 04-20-78 COST OF MONEY 1073 STUDY PERIOD 20 YEARS

PLAN DESCRIPTION: ADD TO MAGNETO SWITCH UNTIL 1985 REPLACEMENT

	CAPITAL REQUIREMENTS FIRST COST		PRESENT WORTH FC		REVENUE REQUIREMENTS ANNUAL COSTS					PRESENT WORTH ANNUAL COST		
NO. CATAGORY, ITEM	AMOUNT	YEAR	PWF	AMOUNT	SFD%	TOT%	AMOUNT	GRT	OPM	LIFE	PW/A	AMOUNT
1 B BLDG ADDITION	$5000	1978	1.000	$5000	10.30	28.10	$1405	$0	$0	7	4.754	$6679
2 MC ADD 100 DROPS	$10000	1979	0.903	$9030	12.70	32.50	$3350	$0	$0	6	3.851	$12901
3 MC ADD 100 DROPS	$12500	1983	0.601	$7513	47.50	69.30	$6538	$0	$0	2	1.022	$9320
4 L NEW LAND	$5000	1984	0.543	$4344	0.00	2.00	$160	$0	$0	30	3.842	$615
5 B NEW BLDG	$36000	1984	0.543	$19548	0.50	12.30	$6588	$0	$0	30	3.842	$25311
6 EC NEW ATOMIC SWITCH	$240000	1985	0.490	$117600	1.60	22.40	$53760	$0	$0	20	3.352	$180204
7 RB RETIRE OLD L& BLDG	-$2333	1985	0.490	-$1143	0.00	4.00	-$93	$0	$0	13	3.352	-$312
8 SB SALVAGE OLD L & BLDG	-$10000	1985	0.490	-$4900	0.00	13.80	-$1380	$0	$0	13	3.352	-$4626
9 RC RETIRE OLD SWITCH	-$14000	1985	0.490	-$6860	0.00	2.00	-$12280	$0	$0	13	3.352	-$41163
10 SC SALVAGE OLD SWITCH	-$500	1985	0.490	-$245	0.00	13.80	-$69	$0	$0	13	3.352	-$231
11 CC CREDIT OPR WAGES	$0	1985	0.000	$0	0.00	0.00	-$80149	$0	$0	13	3.352	-$268659
12 CC CREDIT CUSTOM CALL (NET)	$0	1985	0.000	$0	0.00	0.00	-$6500	$0	$0	13	3.352	-$21788

****

ANNUAL MAINT. ON ITEM 9 IS $12000

TOTAL PRESENT WORTH OF ANNUAL COSTS -$102249
EQUATED ANNUAL CHARGES -$12577

ANNUAL CHARGES SUMMARY FOR DC 500

	MECH COE	ELECTRONIC COE	BLDGS	OUTSIDE PLANT	ELECTRONIC EQUIP
MAINTENCE	5.00	5.00	2.00	0.00	0.00
AD VALOREM TAX	2.00	2.00	2.00	0.00	0.00
INCOME TAX	3.07	3.07	3.07	0.00	0.00
GROSS RECEIPTS TAX	0.00	0.00	0.00	0.00	0.00
COST OF MONEY	10.73	10.73	10.73	10.73	10.73

NOTES:
1. SFD = SINKING FUND DEPRECIATION
2. ANNUAL CHARGES ON RETIREMENTS = MAINTENCE + PROPERTY TAXES
   Maint is calculated to be equal on the old and new switch at the time of retirement
3. ANNUAL CHARGES ON SALVAGE = COST OF MONEY + INCOME TAXES
4. PW/A = FACTOR FOR PRESENT WORTH OF AN ANNUITY (PWAC)
5. COST OF MONEY = %RETURN X %EQUITY + %INTEREST X %DEBT
6. GRT = GROSS RECEIPTS TAX ON REVENUE WHERE APPLICABLE
7. OPM = OUTSIDE PLANT MAINTENANCE AT $ 0 /MILE
8. IF THE LIFE OF AN ITEM EXCEEDS THE STUDY PERIOD IT IS DEFAULTED TO THE END OF THE STUDY PERIOD.

APPENDIX III

PRESENT WORTH OF ANNUAL CHARGES STUDY

Woodman COE

Mi. 656E

CONTENTS

Woodman Telephone Company
Woodman, Michigan
Mi. 656E

Present Worth of Annual Charge Study

Woodman COE

General:

The Woodman Telephone Company faces a central office equipment expansion problem due to continued subscriber growth in the Woodman exchange. The existing CDO building is filled to equipment capacity, and no land is available adjacent to the CDO for a building expansion. The telephone company owns a lot near the existing building suitable for the location of a new building.

This study covers three plans of action that may be taken by the telephone company. Brief descriptions of the three plans follow.

Description of Plans:

Plan 1: Replace existing SxS equipment with digital. The existing SxS equipment will be retired and sold. Service will be provided by means of a leased trailer-mounted SxS office while the existing equipment is removed and the new digital equipment is installed in the existing building. No building addition will be required.

Plan 2: Replace existing SxS equipment with new SxS. The new equipment will be housed in a new building. The existing central office equipment will be retired and sold.

Plan 3: Retain and expand existing SxS equipment. The existing equipment will be removed, refurbished, and reinstalled in a new building. Temporary service while the existing equipment is out of service will be provided by means of a leased trailer-mounted SxS office.

Considerations Other Than Costs:

1. Digital equipment has the capability of providing optional custom calling services (call waiting, call forwarding, three-way calling, and abbreviated dialing). The possibility of additional revenue from these services has not been taken into account in this study.

2. Digital equipment offers the possibility of cost savings in outside plant from the future use of remote switching units, and by lower cost interfaces with PCM trunks. These possible savings were not taken into account in the study.

Summary and Recommendations:

The results of the present worth of annual charge study are summarized as follows:

Plan	Comparative Installed First Cost	Present Worth of Annual Charges
1. Replace existing SxS equipment with digital	$587,400	$901,188
2. Replace existing SxS equipment with new SxS	$610,680	$980,314
3. Retain and expand existing SxS equipment	$515,880	$917,551

On the basis of superior service and lower present worth of annual charges, Plan 1 is recommended.

Prepared By ______________________ Date ____________

Approved By ______________________ Date ____________

PRESENT WORTH OF ANNUAL CHARGES SUMMARY

By BD Date 11-1-78

Plan 1 Description Replace existing SxS equipment with digital Ckd HA Date 11-1-78 Job Mi. 656E

Year Study	Year Def. (N)	Activity	Reference Page	Installed First Cost (IFC)	Annual Charge Factor Or Amount	Present Worth Or Deferred Annuity Factor	Present Worth Of Annual Charges
1980	0	Install 1300 line 40 trunk digital COE	17	$470,400	$90,366	9.129	$824,951
1980	0	Lease 1000 line trailer mounted office	17	25,800			
1985	5	Add 200 lines digital COE	18	45,600	9,071	5.239	47,523
1989	9	Add 200 lines digital COE	19	45,600	9,162	3.134	28,714
		TOTAL		$587,400			$901,188

Notes:

PRESENT WORTH OF ANNUAL CHARGES SUMMARY

By BD Date 11-1-78

Plan 2 Description Replace existing SxS equipment with new SxS Ckd HA Date 11-1-78 Job Mi. 656E

Year Study	Year Def. (N)	Activity	Reference Page	Installed First Cost (IFC)	Annual Charge Factor Or Amount	Present Worth Or Deferred Annuity Factor	Present Worth Of Annual Charges
1980	0	Acquire lot for new CDO building	20	$ 5,000	16.0%	9.129	$ 7,303
1980	0	Build new CDO building	21	68,000	18.4%	9.129	114,222
1980	0	Rearrange outside plant	22	26,500	17.1%	9.129	41,368
1980	0	Install new 1300 line 40 trunk SxS COE	23	371,800	$76,090	9.129	694,626
1985	5	Add 200 lines SxS	24	61,640	13,034	5.239	68,285
1989	9	Add 200 lines SxS	25	77,740	17,393	3.134	54,510
		TOTAL		$610,680			$ 980,314

Notes:

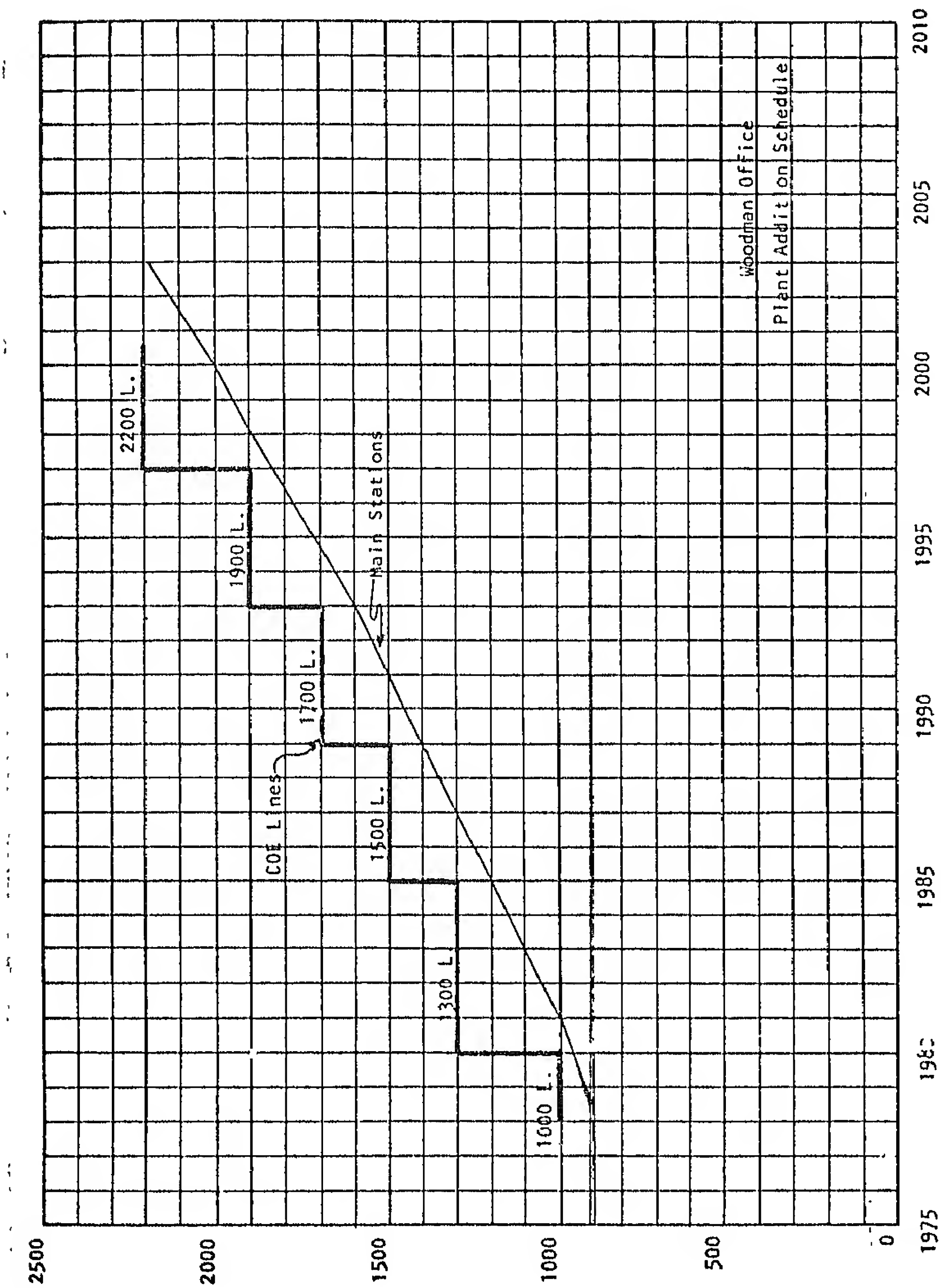
PRESENT WORTH OF ANNUAL CHARGES SUMMARY

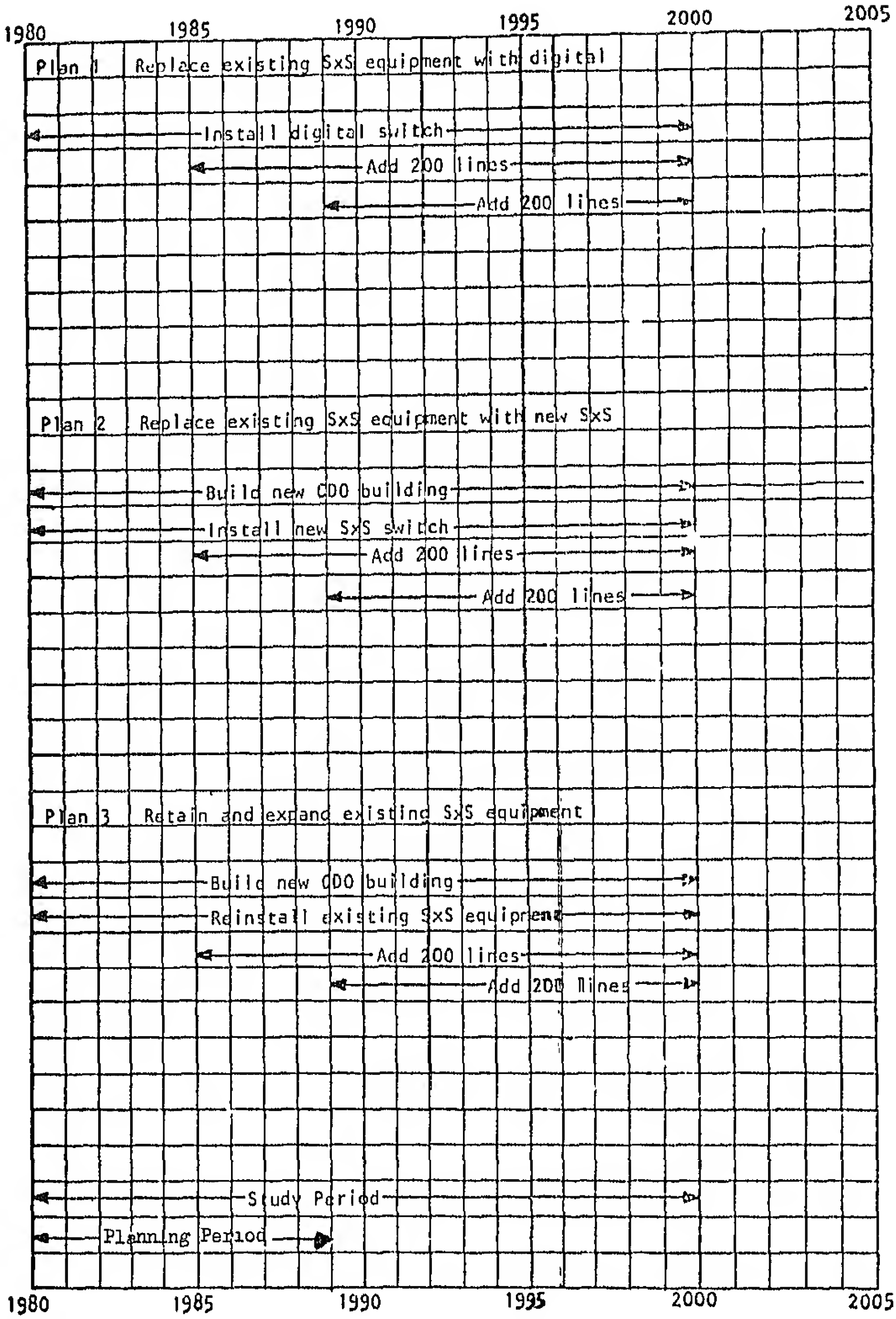
By BD Date 11-1-78
Plan 3 Description Retain and expand existing SxS equipment Ckd HA Date 11-1-78 Job Mi. 656E

Year Study	Year Def. (N)	Activity	Reference Page	Installed First Cost (IFC)	Annual Charge Factor Or Amount	Present Worth Or Deferred Annuity Factor	Present Worth Of Annual Charges
1980	0	Acquire lot for new CDO building	20	$ 5,000	16.0%	9.129	$ 7,303
1980	0	Build new CDO building	21	68,000	18.4%	9.129	114,222
1980	0	Rearrange outside plant	22	26,500	17.1%	9.129	41,368
1980	0	Foregone salvage of ex. SxS equipment	26	50,000			
1980	0	Remove, refurbish, and reinstall ex. equip.	26	125,000	$54,692	9.129	499,283
1980	0	Lease 1000 line trailer mounted office	26	33,000			
1980	0	Add 300 lines SxS	27	69,000	14,523	9.129	132,580
1985	5	Add 200 lines SxS	24	61,640	13,034	5.239	68,285
1989	9	Add 200 lines SxS	25	77,740	17,393	3.134	54,510
		TOTAL		$515,880			$917,551

Notes:

Plant Addition Schedule




1980
1985
1990
1995
2000
2005
Plan 1 Replace existing SxS equipment with digital
Install digital switch
Add 200 lines
Add 200 lines
Plan 2 Replace existing SxS equipment with new SxS
Build new CDO building
Install new SxS switch
Add 200 lines
Add 200 lines
Plan 3 Retain and expand existing SxS equipment
Build new CDO building
Reinstall existing SxS equipment
Add 200 lines
Add 200 lines
Study Period
Planning Period
1980
1985
1990
1995
2000
2005

Derivation of Annual Charges

Annual charges are developed on Annual Charge Computation Sheets using the information listed below.

Cost of Money:

Based on information provided by the Owner and his CPA firm, the following cost of money for future investment during the 20 years of the study period was derived.

Equity Capital:	20% return on 0.25 of total capital =	5 %
Debt Capital :	5% interest on 0.75 of total capital =	3.75%
	Cost of Money =	8.75%
	Use	9.0 %

Depreciation:

Depreciation is based on the following service lines and salvage values:

	Life, Years	% Salvage
Buildings	30	0
Digital COE	*20	As Appropriate
SxS COE	*20	As Appropriate
Outside Plant	25	0

*Central office additions have a service life which ends when the original office service life ends but with salvage based on useful life remaining.

Maintenance:

The following maintenance costs were assumed for cost study purposes:

Buildings	1.5% of original cost
Outside Plant	1.5% of original cost
Digital COE, original installation	$1000 + $5/line
Digital COE addition	$5/line
SxS COE, present equipment rehabilitated on site	$1500 + $15/line
SxS COE, complete office, new	$1000 + $10/line
SxS COE addition, rehabilitated at factory	$10/line

Insurance:

Insurance costs are based on information provided by the Owner:

Buildings	1.56%
Central Office Equipment	0.4 %

Property Tax:

Property taxes are estimated by the Owner to be 2%.

Income Tax:

See the attached two sheets for the method used to compute income tax for each service life and salvage value. The value of the factor a-bc referred to on the two attached sheets is 0.05. (This factor is used on the Annual Charge Computation Sheets for the computation of income tax.) The incremental rate of combined federal and state income taxes (that is, the additional tax resulting from each additional investment) is assumed to be 50%. The effect of investment credit is not taken into account.

Computation Of Income Tax

See Pages 491 - 494 of Chapter 20 of Principles Of Engineering Economy, Sixth Edition, Ronald Press Company, 1976. The terminology is changed to agree with that in TE&CM 219, January, 1978.

Let

a = cost of money

b = interest rate on debt capital

c = debt capital as decimal of total capital

e = effective income tax rate

n = service life on plant

s = salvage value of plant as decimal of first cost

t = income tax as decimal of first cost

(A/G, a%, n) = factor to convert a gradient series to an equivalent uniform annual series A/G (Table D-30 in reference)

Then

$$t = \frac{e}{1 - e} (a - bc) \left[s + (1 - s) \left(1 - \frac{(A/G,\ a\%,\ n)}{n} \right) \right]$$

If e is assumed to be 0.5, and a table is prepared containing values of $\left(1 - \frac{(A/G,\ a\%,\ n)}{n} \right)$ (designated Factor 1 below) for various values of a and n, then the formula becomes:

$$t = (a - bc) \left[S + (1 - s) \text{ (Factor 1)} \right]$$

For simplicity in computation, this may be expressed as:

$$t = (a - bc)\ S + (a - bc)\ (1 - s) \text{ (Factor 1)}$$

Factor 1 For Computation Of Income Tax Rate

The table below shows the value of the factor

$$1 - \frac{(A/G,\ a\%,\ n)}{n}$$

where the values of (A/G, a%, n) are taken from Table D-30 of Principles Of Engineering Economy, Sixth Edition, Ronald Press Company, 1976. Table D-30 contains multipliers for a gradient G to convert the n - year end-of-year series 0, G, 2G,....(n - 1)G to an equivalent uniform annual series for n years.

	a				
n	6%	7%	8%	9%	10%
2	.755	.760	.760	.760	.760
3	.680	.683	.683	.685	.687
4	.642	.645	.650	.653	.655
5	.624	.628	.630	.634	.638
6	.612	.617	.620	.625	.630
7	.604	.610	.616	.621	.626
8	.600	.606	.612	.619	.625
9	.599	.606	.612	.619	.626
10	.598	.605	.613	.620	.627
11	.598	.606	.615	.623	.631
12	.599	.608	.617	.626	.634
13	.601	.611	.620	.629	.638
14	.603	.613	.624	.634	.643
15	.605	.616	.628	.638	.648
16	.607	.619	.631	.642	.653
17	.611	.623	.635	.647	.658
18	.613	.627	.639	.652	.664
19	.616	.631	.644	.657	.669
20	.619	.634	.648	.661	.674
21	.623	.638	.653	.667	.680
22	.626	.642	.657	.671	.685
23	.630	.646	.662	.676	.691
24	.633	.650	.666	.681	.696
25	.637	.654	.671	.687	.702
26	.641	.658	.675	.691	.707
27	.644	.663	.680	.696	.712
28	.648	.667	.685	.701	.717
29	.652	.671	.689	.706	.722
30	.655	.675	.694	.711	.727

n is the number of years over which the plant is depreciated (service life).

Basis For Costs

Plan 1   Replace existing SxS equipment with digital.

Plan 2   Replace existing SxS equipment with new SxS.

Plan 3   Retain and expand existing SxS equipment.

Item	Plans Applicable To
All costs include engineering and overhead.	All
The present cost of SxS additions is assumed to increase 6% a year due to inflation.	2,3
Digital COE is assumed to remain at present prices over the study period. This assumption is based on the tendency for the price of electronic equipment to decrease in comparative costs as development costs are recovered and cost reduction methods are developed.	1
Current digital equipment costs for a new office are estimated as $150,000 per office plus $228 per line plus $600 per trunk.	1
Current digital equipment addition costs are assumed to be $228 per line.	1
Current new X-Y equipment costs are assumed to be $286 per line for 1300 lines.	2
Current reconditioned X-Y equipment addition costs are assumed to be $230 per line.	2,3
The net salvage value of the existing 1000 line 1100 terminal X-Y equipment is assumed to be $50 per line.	3
The lease cost for trailer mounted equipment is based on estimates provided by independent installers in this area. The Plan 1 cost for a 90 day lease is $25,800; the Plan 3 cost for a 150 day lease is $33,000.	1,3

Item	Plans Applicable To
The cost of removing, refurbishing, and reinstalling the existing 1000 line office is estimated to be approximately 55% of the current cost of $230 per line for reconditioned equipment, or $125 per line.	3
The retirement of the existing equipment in Plans 1 and 2 is accounted for in Plan 3, as recommended in Engineering Ecomony, McGraw Hill, 1977, page 326 (the AT&T "Green Book").	3
Current new CDO building prices in this area are $68 per square foot.	2,3
The Owner has no planned use for the existing switching room, which will be surplus if a new CDO building is constructed in Plans 2 and 3. For cost study purposes, it is assumed that over the 20 year period of the study, the value of this surplus floor space to the Owner will equal the annual costs. The annual costs are therefore not considered to be a factor in this study.	2,3

Inflation Factors

(6% annual inflation, compounded)

Year	Factor
0	1.00
1	1.06
2	1.12
3	1.19
4	1.26
5	1.34
6	1.42
7	1.50
8	1.59
9	1.69
10	1.79
11	1.90
12	2.01
13	2.13
14	2.26
15	2.40
16	2.54
17	2.69
18	2.85
19	3.03
20	3.21

Deferred Annuity Factors

Planning Period: 20 Years

Cost of Money: 9%

n	Factor
0	9.129
1	8.212
2	7.370
3	6.598
4	5.889
5	5.239
6	4.643
7	4.096
8	3.594
9	3.134
10	2.711
11	2.324
12	1.968
13	1.642
14	1.343
15	1.068
16	0.816
17	0.585
18	0.373
19	0.179
20	0

The above table lists values of $(p/a)_{20}^{9\%} - (p/a)_{n}^{9\%}$.

Refer to REA TE&CM 219, Exhibit 6.

n = number of years deferred.

Job ______

By BD Date 11-1-78

Ckd HA Date 11-1-78

Annual Charge Computation Sheet

Plan 1

Activity: Install 1300 line 40 trunk digital COE
Lease 1000 line trailer mounted office

Service Life 20 Yrs. Salvage s $\boxed{0\ \%}$. Yr. Installed 80 Yr. Retired 00

Remarks: COE = $150,000 + 1300 X $228 + 40 X $600 = $470,400.
Trailer lease for 90 days = $25,800. Total $496,200

	Annual Cost %	Annual Cost Amount
Cost Of Money:	9.0%	$44,658
Depreciation. Sinking Fund Factor = .01955 (Note 1) X $\boxed{1.0}$ (1-s)(dec) X 100 = 1.955% Use	2.0%	$ 9,924
Maintenance: $1000 + $5/line	- %	$ 7,500
Insurance:	0.4%	$ 1,985
Property Tax:	2.0%	$ 9,924

Income Tax: Note 2

(a - bc)(dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = -

+

(a - bc)(dec) $\boxed{0.05}$ X (1-s)(dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{0.661}$ = 0.0331

X 100 = 3.3% $16,375

Total Annual Cost - % $90,366

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.

(2) (a - bc) is from separate sheet.

(3) From separate table.

(4) $\boxed{\quad}$ Indicates same figure is used elsewhere on this sheet.

Job ________

Annual Charge Computation Sheet

Plan 1

By BD Date 11-1-78

Ckd HA Date 11-1-78

Activity: Add 200 lines digital COE

Service Life 15 Yrs. Salvage $\boxed{20\ \%}$ (s). Yr. Installed 85 Yr. Retired 00

Remarks: Cost = \$228/line = \$45,600

		Annual Cost %	Annual Cost Amount
Cost Of Money:		9.0%	\$ 4,104
Depreciation:	Sinking Fund Factor = 0.03406 (Note 1) X $\boxed{0.8}$ (1-s) (dec) X 100 = 2.725 Use	2.7	\$ 1,231
Maintenance:	\$5/line	- %	\$ 1,000
Insurance:		0.4%	\$ 182
Property Tax:		2.0%	\$ 912

Income Tax: Note 2

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{.20}$ = 0.0100

\+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{0.8}$ X Note 3 Factor 1 (dec) $\boxed{0.638}$ = 0.0255

X 100 = 3.6 % \$ 1,642

Total Annual Cost - % \$ 9,071

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.

(2) (a - bc) is from separate sheet.

(3) From separate table.

(4) $\boxed{}$ indicates same figure is used elsewhere on this sheet.

Job ______
By BD Date 11-1-78
Ckd HA Date 11-1-78

Annual Charge Computation Sheet
Plan 1

Activity: Add 200 lines digital COE

Service Life 11 Yrs. Salvage $\boxed{60\ \%}$ (s). Yr. Installed 89 Yr. Retired 00

Remarks: Cost = $228/line = $45,600

	Annual Cost %	Annual Cost Amount
Cost Of Money:	9.0%	$ 4,104
Depreciation: Sinking Fund Factor = 0.05695 (Note 1) X $\boxed{0.4}$ (1-s)(dec) X 100 = 2.278 Use	2.3	$ 1,049
Maintenance: $5/line	- %	$ 1,000
Insurance:	0.4%	$ 182
Property Tax:	2.0%	$ 912

Income Tax: Note 2

(a - bc)(dec) $\boxed{0.05}$ X s(dec) $\boxed{0.6}$ = 0.0300
+
(a - bc)(dec) $\boxed{0.05}$ X (1-s)(dec) $\boxed{0.4}$ X Note 3 Factor 1 (dec) $\boxed{0.623}$ = 0.01246

X 100 = 4.2% $ 1,915

Total Annual Cost - % $ 9,162

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.
(2) (a - bc) is from separate sheet.
(3) From separate table.
(4) $\boxed{}$ indicates same figure is used elsewhere on this sheet.

Job ______
By BO Date 11-1-78
Ckd HA Date 11-1-78

Annual Charge Computation Sheet
Plan 2 and 3

Activity: Acquire lot for new building

Service Life ___ Yrs. Salvage $\boxed{100\ \%}$ (s). Yr. Installed 80 Yr. Retired 00

Remarks: The lot is already owned by the telephone company. The estimated value is $5,000.

		Annual Cost %	Annual Cost Amount
Cost Of Money:		9.0 %	$
Depreciation: Sinking Fund Factor =	Note 1: - × (1-s) (dec) $\boxed{0}$ × 100 = 0 % Use	0 %	$
Maintenance:		0 %	$
Insurance:		0 %	$
Property Tax:		2.0 %	$

Income Tax: Note 2

(a - bc) (dec) $\boxed{0.05}$ × s(dec) $\boxed{1.0}$ = 0.05

+

(a - bc) (dec) $\boxed{0.05}$ × (1-s) (dec) $\boxed{0}$ × Note 3 Factor 1 (dec) $\boxed{-}$ = 0

× 100 = 5.0 % $ ______

Total Annual Cost 16.0 % $ ______

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.
(2) (a - bc) is from separate sheet.
(3) From separate table.
(4) $\boxed{}$ indicates same figure is used elsewhere on this sheet.

Job ______

Annual Charge Computation Sheet
Plan 2 and 3

By BD Date 11-1-78
Ckd HA Date 11-1-78

Activity: Build new CDO building.

Service Life 30 Yrs. Salvage $\boxed{0\ \%}$. Yr. Installed 80 Yr. Retired 10

Remarks: Estimated cost: 1000 sq. ft. @ $68 = $68,000

	Annual Cost %	Amount
Cost Of Money:	9.0 %	$
Depreciation: Sinking Fund Factor = 0.00734 (Note 1) X $\boxed{1.0}$ (1-s)(dec) X 100 = .734% Use	0.7 %	$
Maintenance:	1.5 %	$
Insurance:	1.6 %	$
Property Tax:	2.0 %	$

Income Tax: Note 2

(a - bc)(dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = -

(a - bc)(dec) $\boxed{0.05}$ X (1-s)(dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{0.711}$ = 0.03555 +

X 100 = 3.6 % $

Total Annual Cost 18.4 % $

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.

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(3) From separate table.

(4) $\boxed{}$ Indicates same figure is used elsewhere on this sheet.

Annual Charge Computation Sheet

Plan 2 and 3

Job ______

By BD Date 11-1-78

Ckd HA Date 11-1-78

Activity: Rearrange outside plant

Service Life 25 Yrs. Salvage $\boxed{0\ \%}$ (s). Yr. Installed 80 Yr. Retired 05

Remarks: This cost covers the outside plant rearrangements made necessary by moving the central office from its present location to the new location. (Estimated Cost: $26,500)

	Annual Cost %	Amount
Cost Of Money:	9.0 %	$
Depreciation: Sinking Fund Factor = 0.01181 (Note 1) X $\boxed{1.0}$ (1-s) (dec) X 100 = 1.181% Use	1.2 %	$
Maintenance:	1.5 %	$
Insurance:	- %	$
Property Tax:	2.0 %	$

Income Tax: Note 2

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = -

+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{.687}$ = 0.03435

X 100 = 3.4 % $

Total Annual Cost 17.1 % $

Notes:

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(3) From separate table.

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Job ______

Annual Charge Computation Sheet
Plan 2

By 80 Date 11-1-78
Ckd HA Date 11-1-78

Activity: Install new 1300 line 40 trunk, SxS COE

Service Life 20 Yrs. **Salvage** s: $\boxed{0\ \%}$. **Yr. Installed** 80 **Yr. Retired** 00

Remarks: Cost = $286/line = $371,800

	Annual Cost %	Annual Cost Amount
Cost Of Money:	9.0 %	$ 33,462
Depreciation: Sinking Fund Factor = 0.01955 (Note 1) X $\boxed{1.0}$ (1-s) (dec) X 100 = 1.955 % Use	2.0 %	$ 7,436
Maintenance: $1000 + $10/line	- %	$ 14,000
Insurance:	0.4 %	$ 1,487
Property Tax:	2.0 %	$ 7,436
Income Tax: Note 2		

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = -

+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{0.661}$ = 0.03305

X 100 = 3.3 % $ 12,269

Total Annual Cost - % $ 76,090

Notes:

(1) (a/f), a%, n from Exhibit 2, TE&CM 219.

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Job ______

By BD Date 11-1-78

Ckd HA Date 11-1-78

Annual Charge Computation Sheet

Plan 2 and 3

Activity: Add 200 lines, SxS

Service Life 15 Yrs. Salvage $\boxed{5\ \%}$ (s). Yr. Installed 85 Yr. Retired 00

Remarks: Cost = \$230/line x 1.34 (inflation factor) = \$61,640

	Annual Cost %	Annual Cost Amount
Cost Of Money:	0.9 %	\$ 5,548
Depreciation: Sinking Fund Factor = 0.03406 (Note 1) X $\boxed{0.95}$ (1-s) (dec) X 100 = 3.236% Use	3.2 %	\$ 1,972
Maintenance: \$10/line	- %	\$ 2,000
Insurance:	0.4 %	\$ 247
Property Tax:	2.0 %	\$ 1,233

Income Tax: Note 2

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0.05}$ = 0.0025

\+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{0.95}$ X Note 3 Factor I (dec) $\boxed{0.638}$ = 0.0303

X 100 = 3.3 % \$ 2,034

Total Annual Cost - % \$ 13,034

Notes:

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(2) (a - bc) is from separate sheet.

(3) From separate table.

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Annual Charge Computation Sheet
Plan 2 and 3

Job ______
By BD Date 11-1-78
Ckd HA Date 11-1-78

Activity: Add 200 lines, SxS

Service Life 11 Yrs. Salvage $\boxed{10\ \%}$ s . Yr. Installed 89 Yr. Retired 00

Remarks: Cost = $230/line x 1.69 (inflation factor) = $77,740

	Annual Cost %	Annual Cost Amount
Cost Of Money:	9.0 %	$ 6,997
Depreciation: Sinking Fund Factor = 0.05695 (Note 1) X $\boxed{0.9}$ (1-s)(dec) X 100 = 5.126 Use	5.1 %	$ 3,965
Maintenance: $10/line	- %	$ 2,000
Insurance:	0.4 %	$ 311
Property Tax:	2.0 %	$ 1,555
Income Tax: Note 2		

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0.1}$ = 0.0050

+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{0.9}$ X Note 3 Factor 1 (dec) $\boxed{0.623}$ = 0.02804

X 100 = 3.3 % $ 2,565

Total Annual Cost - % $ 17,393

Notes:

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Job ______ ______

Annual Charge Computation Sheet — By: BD, Date: 11-1-78

Plan 3 — Ckd: HA, Date: 11-1-78

Activity: Foregone salvage of existing SxS equipment
Remove, refurbish, and reinstall existing equipment
Lease 1000 line trailer mounted office

Service Life 20 Yrs. Salvage $\boxed{0\ \%}$ (s). Yr. Installed 80 Yr. Retired 00

Remarks: Net salvage of existing 1000 line SxS equipment is $50/line, or $50,000. Remove, refurbish, and reinstall 1000 line SxS equipment is $125/line or $125,000. Lease of trailer mounted equipment for 150 days is $33,000. Total cost is $ 208,000.

	Annual Cost %	Amount
Cost Of Money: ($ 208,000)	9.0%	$ 18,720
Depreciation: ($208,000) Note 1 Sinking Fund Factor = 0.01955 X $\boxed{1.0}$ (1-s) (dec) X 100 = 1.955% Use	2.0%	$ 4,160
Maintenance: $1500 + $15/line	- %	$ 16,500
Insurance: Assume insurance and property tax apply to COE original cost of $194,000 + above costs of $125,000 and $33,000, or $352,000 total	0.4%	$ 1,408
Property Tax:	2.0%	$ 7,040

Income Tax: Note 2 ($ 208,000)

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = -

\+

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{0.661}$ = 0.0331

X 100 = 3.3% $ 6,864

Total Annual Cost - % $ 54,692

Notes:

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(3) From separate table.

(4) $\boxed{\quad}$ Indicates same figure is used elsewhere on this sheet.

Job ______________________

Annual Charge Computation Sheet
Plan 3

By BD Date 11-1-78
Ckd HA Date 11-1-78

Activity: Add 300 lines, SxS

Service Life 20 Yrs. Salvage $\boxed{0 \%}$ (s). Yr. Installed 80 Yr. Retired 00

Remarks: Cost = $230/line = $69,000

		Annual Cost %	Annual Cost Amount
Cost Of Money:		9.0 %	$ 6,210
Depreciation: Sinking Fund Factor =	Note 1: 0.01955 X (1-s)(dec) $\boxed{1.0}$ X 100 = 1.955% Use	2.0 %	$ 1,380
Maintenance:	$10/line	- %	$ 3,000
Insurance:		0.4 %	$ 276
Property Tax:		2.0 %	$ 1,380

Income Tax: Note 2

(a - bc) (dec) $\boxed{0.05}$ X s(dec) $\boxed{0}$ = ______ -

(a - bc) (dec) $\boxed{0.05}$ X (1-s) (dec) $\boxed{1.0}$ X Note 3 Factor 1 (dec) $\boxed{0.6611}$ = 0.03305 +

X 100 = 3.3 % $ 2,277

Total Annual Cost - % $ 14,523

Notes:

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